

FCC

RF

TEST REPORT

ISSUED BY  
Shenzhen BALUN Technology Co., Ltd.



FOR  
**RHF1S001 IP64 T&H sensor**

ISSUED TO  
RuiXingHengFang Network (Shenzhen) CO., Ltd

Suite B3019, 3rd tower of Elite(YiLiDa) building, NO.1092 NanShan  
blvd. NanShan District, Shenzhen 518054 China



Tested by:

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Date Nov. 15, 2016

Approved by:

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(Technical Director)

Date Nov. 15, 2016

Report No.: BL-SZ1690394-601

EUT Type: RHF1S001 IP64 T&H sensor

Model Name: RHF1S001

Brand Name: RisingHF

Test Standard: 47 CFR Part 15 Subpart C

FCC ID: 2AJUZ1S001

Test conclusion: Pass

Test Date: Oct. 19, 2016 ~ Nov. 01, 2016

Date of Issue: Nov. 15, 2016

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**Revision History**

<u>Version</u>	<u>Issue Date</u>	<u>Revisions Content</u>
Rev. 01	Nov. 08, 2016	Initial Issue
Rev. 02	Nov. 15, 2016	Update the chapter number and relative limit.

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# 1 ADMINISTRATIVE DATA (GENERAL INFORMATION)

## 1.1 Identification of the Testing Laboratory

Company Name	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Phone Number	+86 755 6685 0100
Fax Number	+86 755 6182 4271

## 1.2 Identification of the Responsible Testing Location

Test Location	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Accreditation Certificate	The laboratory has been listed by Industry Canada to perform electromagnetic emission measurements. The recognition numbers of test site are 11524A-1. The laboratory has been listed by US Federal Communications Commission to perform electromagnetic emission measurements. The recognition numbers of test site are 832625. The laboratory is a testing organization accredited by China National Accreditation Service for Conformity Assessment (CNAS) according to ISO/IEC 17025. The accreditation certificate number is L6791.
Description	All measurement facilities used to collect the measurement data are located at Block B, FL 1, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China 518055

## 1.3 Laboratory Condition

Ambient Temperature	20 to 25°C
Ambient Relative Humidity	45% - 55%
Ambient Pressure	100 kPa - 102 kPa

## 1.4 Announce

- (1) The test report reference to the report template version v4.5.
- (2) The test report is invalid if not marked with the signatures of the persons responsible for preparing and approving the test report.
- (3) The test report is invalid if there is any evidence and/or falsification.
- (4) The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein.
- (5) This document may not be altered or revised in any way unless done so by BALUN and all revisions are duly noted in the revisions section.
- (6) Content of the test report, in part or in full, cannot be used for publicity and/or promotional purposes without prior written approval from the laboratory.

## 2 PRODUCT INFORMATION

### 2.1 Applicant Information

Applicant	RuiXingHengFang Network(Shenzhen)CO., Ltd
Address	Suite B3019, 3rd tower of Elite(YiLiDa) building, NO.1092 NanShan blvd. NanShan District, Shenzhen 518054 China

### 2.2 Manufacturer Information

Manufacturer	RuiXingHengFang Network(Shenzhen)CO., Ltd
Address	Suite B3019, 3rd tower of Elite(YiLiDa) building, NO.1092 NanShan blvd. NanShan District, Shenzhen 518054 China

### 2.3 Factory Information

Factory	RuiXingHengFang Network(Shenzhen)CO., Ltd
Address	Suite B3019, 3rd tower of Elite(YiLiDa) building, NO.1092 NanShan blvd. NanShan District, Shenzhen 518054 China

### 2.4 General Description for Equipment under Test (EUT)

EUT Type	RHF1S001 IP64 T&H sensor
Model Name Under Test	RHF1S001
Series Model Name	N/A
Description of Model name differentiation	N/A
Hardware Version	V1.0
Software Version	RHF1S001: V2.0.3
Dimensions (Approx.)	N/A
Weight (Approx.)	N/A
Network and Wireless connectivity	Lora Spread Spectrum, LoraWAN

### 2.5 Ancillary Equipment

Ancillary Equipment 1	Battery	
	Brand Name	EVE Energy Co., Ltd
	Model No.	ER34615
	Serial No.	N/A
	Capacitance	19000 mAh
	Rated Voltage	3.6 V
	Limit Charge Voltage	N/A

## 2.6 Technical Information

The requirement for the following technical information of the EUT was tested in this report:

Modulation Technology	Frequency hopping system, Hybrid system
Modulation Type	LoRa
Product Type	Mobile and portable
Frequency Range	The frequency range used is 902 MHz to 928 MHz.
Number of channel	64
Tested Channel	0 (902.3 MHz), 32 (908.7 MHz), 63 (914.9 MHz)
Antenna Type	PIFA Antenna
Antenna Gain	-2 dBi (All involve the antenna gain test item, has been included in the final results)
Antenna System(MIMO Smart Antenna)	N/A
About the Product	The EUT is supply the DTS, Frequency hopping system and Hybrid system, only the frequency hopping system and hybrid system were tested in this report.

All channel was listed on the following table:

Channel number	Freq. (MHz)	Channel number	Freq. (MHz)	Channel number	Freq. (MHz)	Channel number	Freq. (MHz)
0	902.3	20	906.3	40	910.3	60	914.3
1	902.5	21	906.5	41	910.5	61	914.5
2	902.7	22	906.7	42	910.7	62	914.7
3	902.9	23	906.9	43	910.9	63	914.9
4	903.1	24	907.1	44	911.1	-	-
5	903.3	25	907.3	45	911.3	-	-
6	903.5	26	907.5	46	911.5	-	-
7	903.7	27	907.7	47	911.7	-	-
8	903.9	28	907.9	48	911.9	-	-
9	904.1	29	908.1	49	912.1	-	-
10	904.3	30	908.3	50	912.3	-	-
11	904.5	31	908.5	51	912.5	-	-
12	904.7	32	908.7	52	912.7	-	-
13	904.9	33	908.9	53	912.9	-	-
14	905.1	34	909.1	54	913.1	-	-
15	905.3	35	909.3	55	913.3	-	-
16	905.5	36	909.5	56	913.5	-	-
17	905.7	37	909.7	57	913.7	-	-
18	905.9	38	909.9	58	913.9	-	-
19	906.1	39	910.1	59	914.1	-	-



## 2.7 Additional Instructions

EUT Software Settings:

Mode	<input checked="" type="checkbox"/> Special software is used. The software provided by client to enable the EUT under transmission condition continuously at specific channel frequencies individually.
------	--

During testing. Channel and Power Controlling Software provided by the customer was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the customer and is going to be fixed on the firmware of the final end product.

Power level setup in software		
Test Software Version		
Mode	Channel	Soft Set
LoRa	ALL	8

Run Software

```
d:\rcfg>rcfg -t normal
RisingHF device(COM17) found, Version: 2.1.3
Set test mode successfully

d:\rcfg>rcfg.exe -t RXCLORA -P "902300000,7,125000,12,12,8"
```

### 3 SUMMARY OF TEST RESULTS

#### 3.1 Test Standards

No.	Identity	Document Title
1	47 CFR Part 15, Subpart C (10-1-15 Edition)	Miscellaneous Wireless Communications Services
2	FCC PUBLIC NOTICE DA 00-705 (Mar. 30, 2000)	Filling and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems
3	ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices

### 3.2 Verdict

No.	Description	FCC Part No.	Modulation Technology	Channel	Test Result	Verdict	Remark
1	Antenna Requirement	15.203	N/A	N/A	--	Pass	Note 1
2	Number of Hopping Frequencies	15.247(a)	Frequency hopping system	Hopping	ANNEX A.1	Pass	
3	Peak Output Power	15.247(b)	Frequency hopping system, Hybrid system	Low/Middle/High	ANNEX A.2	Pass	
4	Occupied Bandwidth	15.247(a)	Frequency hopping system, Hybrid system	Low/Middle/High	ANNEX A.3	Pass	
5	Carrier Frequency Separation	15.247(a)	Frequency hopping system, Hybrid system	Hopping Mode	ANNEX A.4	Pass	
6	Time of Occupancy (Dwell time)	15.247(a)	Frequency hopping system, Hybrid system	Hopping	ANNEX A.5	Pass	
7	Conducted Spurious Emission & Authorized-band band-edge	15.247(d)	Frequency hopping system, Hybrid system	Low/Middle/High	ANNEX A.6	Pass	
8	Conducted Emission	15.207	Frequency hopping system, Hybrid system	Low/Middle/High	ANNEX A.7	N/A	Note 2
9	Radiated Spurious Emission	15.209 15.247(d)	Frequency hopping system, Hybrid system	Hopping, Low/Middle/High	ANNEX A.8	Pass	
10	Band Edge(Restricted-band band-edge)	15.209 15.247(d)	Frequency hopping system, Hybrid system	Hopping, Low/Middle/High	ANNEX A.9	Pass	
11	Power spectral density (PSD)	15.247(e)	Hybrid system	Low/Middle/High	ANNEX A.10	Pass	

Note 1: Please refer to section 5.1

Note 2: The EUT is supply by battery, so the Conducted Emission is not applicable.

## 4 GENERAL TEST CONFIGURATIONS

### 4.1 Test Environments

During the measurement, the normal environmental conditions were within the listed ranges:

Relative Humidity	45% - 55%	
Atmospheric Pressure	100 kPa - 102 kPa	
Temperature	NT (Normal Temperature)	+22°C to +25°C
Working Voltage of the EUT	NV (Normal Voltage)	3.7 V

### 4.2 Test Equipment List

Description	Manufacturer	Model	Serial No.	Cal. Date	Cal. Due
Spectrum Analyzer	ROHDE&SCHWARZ	FSV-30	103118	2016.07.13	2017.07.12
Vector Signal Generator	ROHDE&SCHWARZ	SMBV100A	177746	2016.07.13	2017.07.12
Signal Generator	ROHDE&SCHWARZ	SMB100A	260592	2016.07.13	2017.07.12
Switch Unit with OSP-B157	ROHDE&SCHWARZ	OSP120	101270	2016.07.13	2017.07.12
Spectrum Analyzer	AGILENT	E4440A	MY45304434	2015.10.15	2016.10.14
EMI Receiver	ROHDE&SCHWARZ	ESRP	101036	2016.07.05	2017.07.04
LISN	SCHWARZBECK	NSLK 8127	8127-687	2016.07.05	2017.07.04
Bluetooth Tester	ROHDE&SCHWARZ	CBT	101005	2016.07.13	2017.07.12
Power Splitter	KMW	DCPD-LDC	1305003215	--	--
Power Sensor	ROHDE&SCHWARZ	NRP-Z21	103971	2016.07.13	2017.07.12
Attenuator (20 dB)	KMW	ZA-S1-201	110617091	--	--
Attenuator (6 dB)	KMW	ZA-S1-61	1305003189	--	--
DC Power Supply	ROHDE&SCHWARZ	HMP2020	018141664	2016.07.13	2017.07.12
Temperature Chamber	ANGELANTIONI SCIENCE	NTH64-40A	1310	2016.07.13	2017.07.12
Test Antenna-Loop(9 kHz-30 MHz)	SCHWARZBECK	FMZB 1519	1519-037	2015.07.22	2017.07.21
Test Antenna-Bi-Log(30 MHz-3 GHz)	SCHWARZBECK	VULB 9163	9163-624	2015.07.22	2017.07.21
Test Antenna-Horn(1-18 GHz)	SCHWARZBECK	BBHA 9120D	9120D-1148	2015.07.22	2017.07.21
Test Antenna-Horn(15-26.5 GHz)	SCHWARZBECK	BBHA 9170	9170-305	2015.07.22	2017.07.21
Anechoic Chamber	RAINFORD	9m*6m*6m	N/A	2015.02.28	2017.02.27
Shielded Enclosure	ChangNing	CN-130701	130703	--	--

### 4.3 Measurement Uncertainty

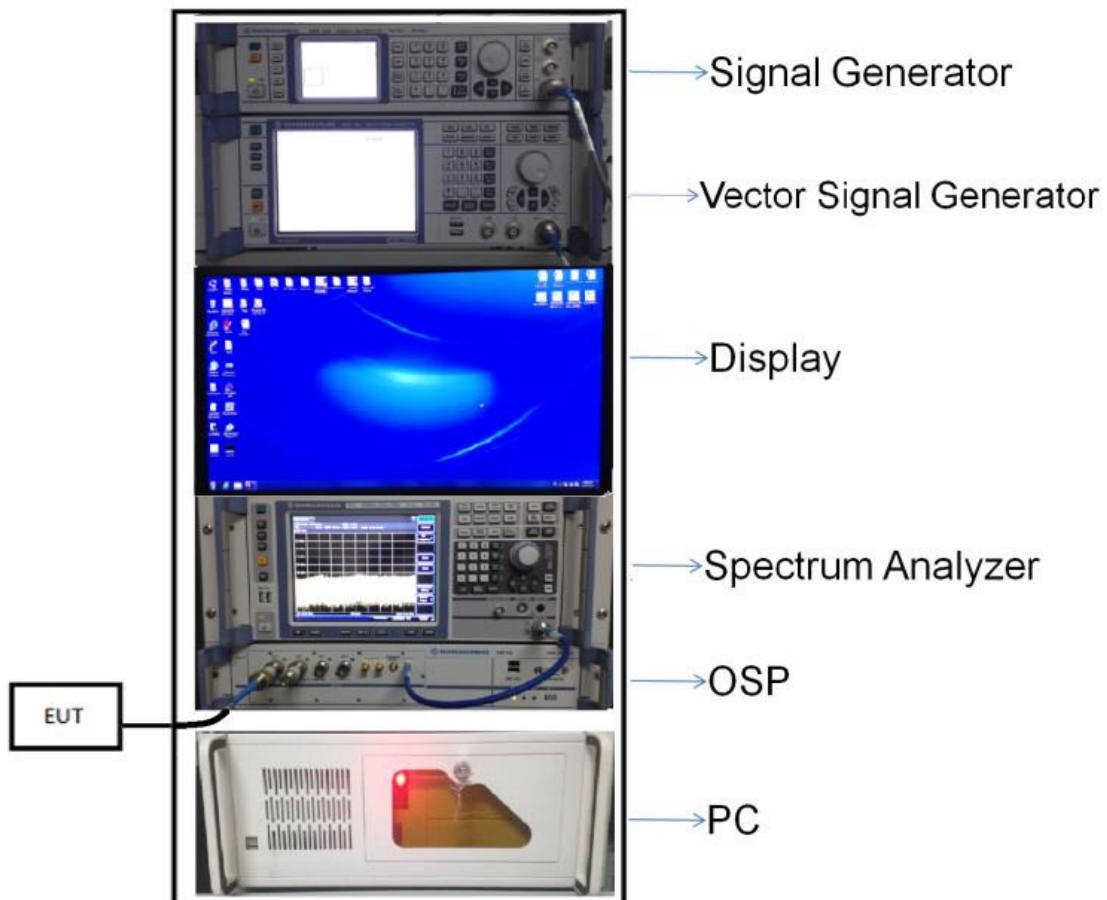
The following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2.

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of  $k=2$ .

Measurement	Value
Occupied Channel Bandwidth	$\pm 4\%$
RF output power, conducted	$\pm 1.4$ dB
Power Spectral Density, conducted	$\pm 2.5$ dB
Unwanted Emissions, conducted	$\pm 2.8$ dB
All emissions, radiated	$\pm 5.4$ dB
Temperature	$\pm 1^\circ\text{C}$
Humidity	$\pm 4\%$

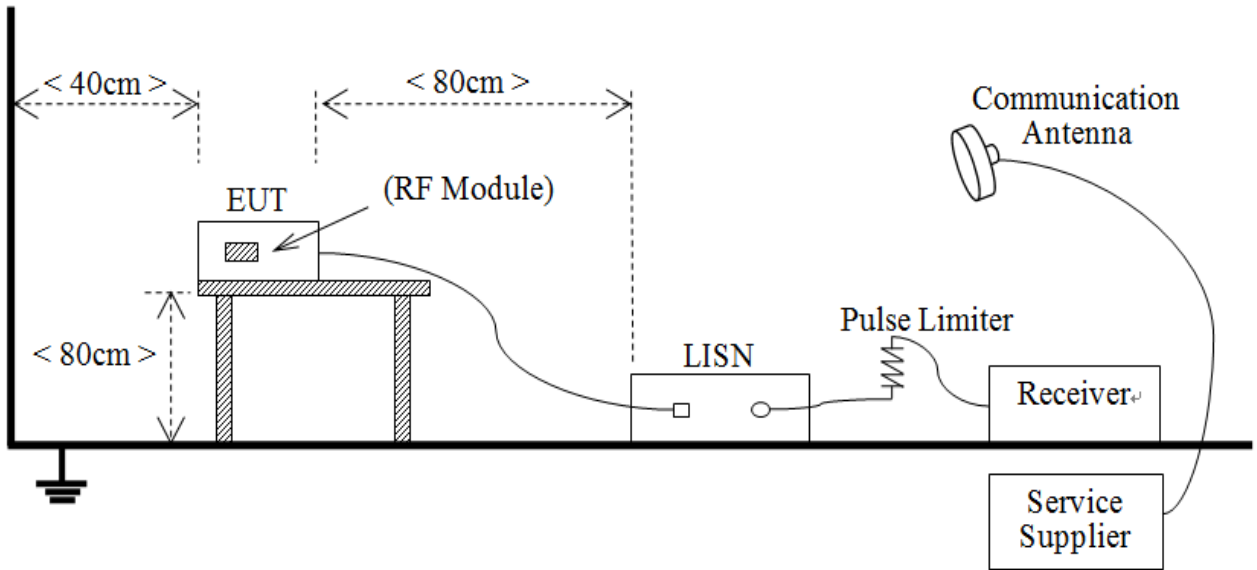
### 4.4 Description of Test Setup

#### 4.4.1 For Antenna Port Test



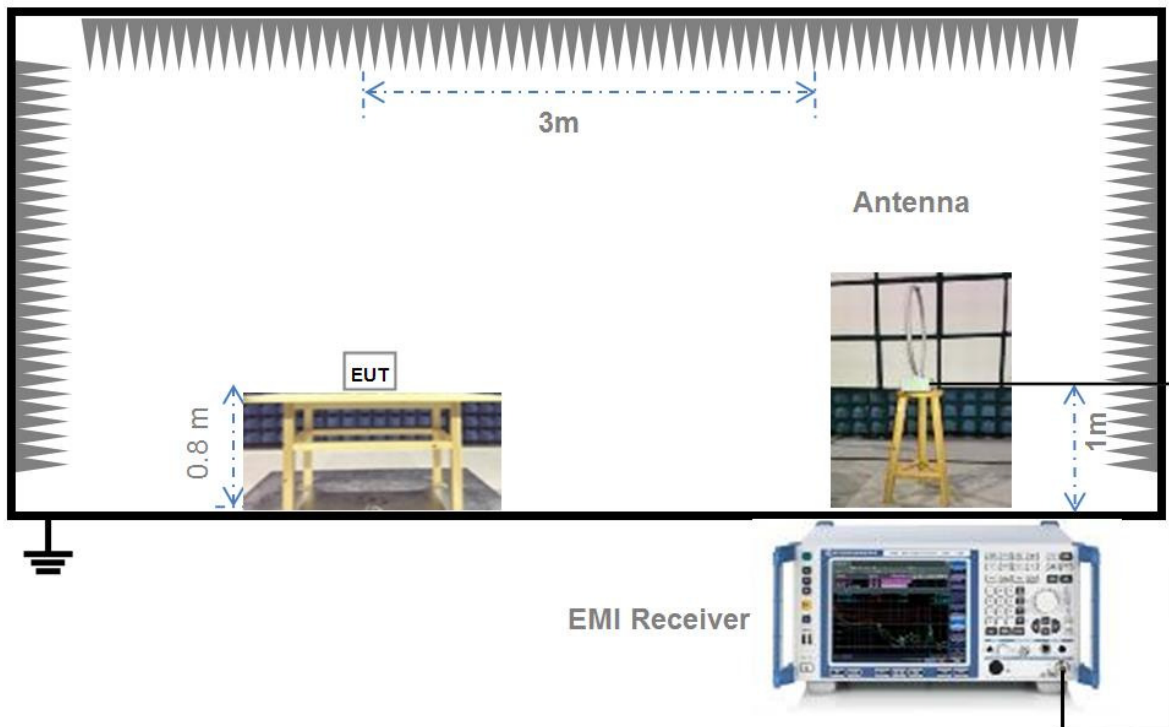
(Diagram 1)

4.4.2 For AC Power Supply Port Test



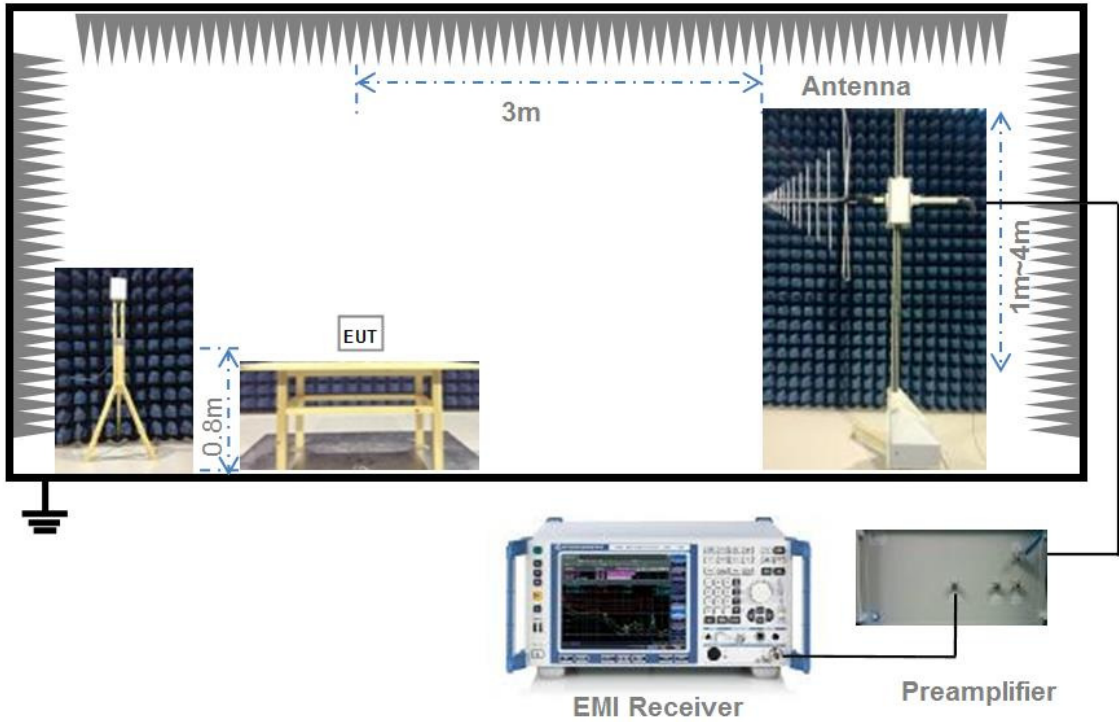
(Diagram 2)

4.4.3 For Radiated Test (Below 30 MHz)



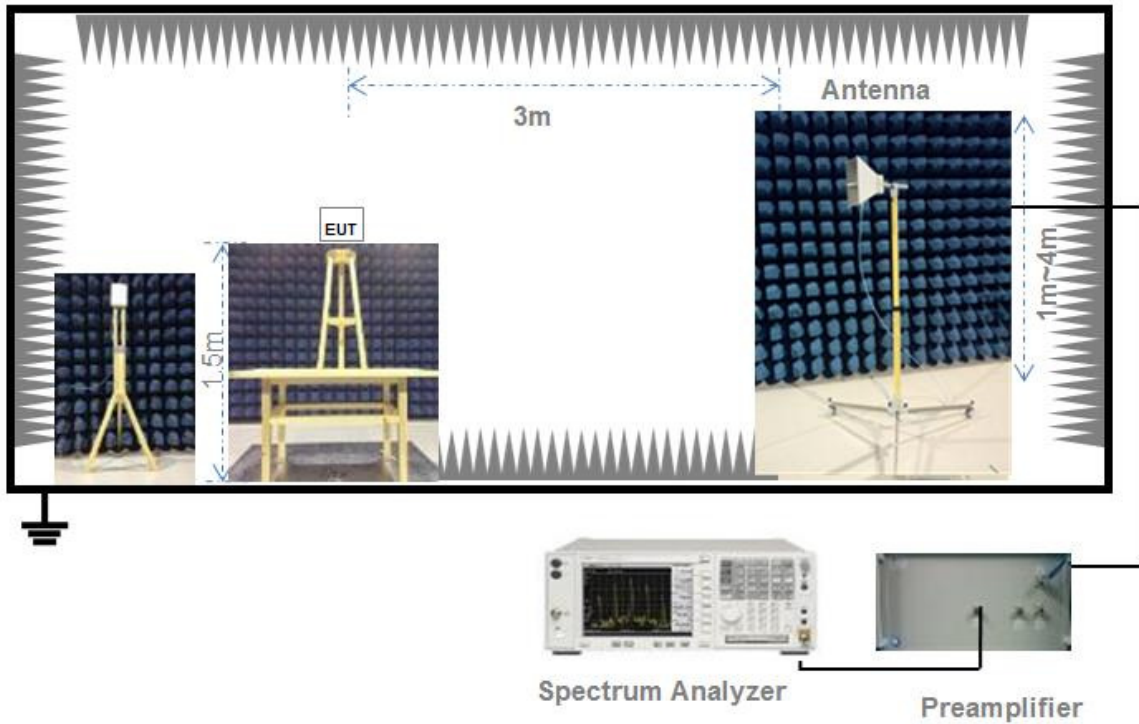
(Diagram 3)

4.4.4 For Radiated Test (30 MHz-1 GHz)



(Diagram 4)

4.4.5 For Radiated Test (Above 1 GHz)



(Diagram 5)

## 4.5 Measurement Results Explanation Example

### 4.5.1 For conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

The spectrum analyzer offset is derived from RF cable loss and attenuator factor.

Offset = RF cable loss + attenuator factor.

### 4.5.2 For radiated band edges and spurious emission test:

Per part 15.35(c), the EUT Bluetooth average emission level could be determined by the peak emission level applying duty cycle correction factor, to represent averaging over the whole pulse train.

The average level is derived from the peak level corrected with "Duty cycle correction factor".

Average Emission Level (dBuV/m) = Peak Emission Level (dBuV/m) + Duty cycle correction factor (dB)

Duty cycle correction factor (dB) =  $20 * \log(\text{Duty cycle})$ .

Duty cycle = on time / 100 milliseconds

On time = dwell time \* hopping number in 100 ms

For example: bluetooth with dwell time 2.9 ms and 3 hops in 100 ms, then

Duty cycle correction factor (dB) =  $20 * \log((2.9 * 3) / 100) = -21.21 \text{ dB}$

Following shows an average computation example with duty cycle correction factor = -21.21 dB, and the peak emission level is 45.61 dBuV/m.

Example:

Average Emission Level (dBuV/m) = Peak Emission Level (dBuV/m) + duty cycle correction factor (dB)  
=  $45.61 + (-21.21) = 24.4 \text{ (dBuV/m)}$



## 5 TEST ITEMS

### 5.1 Antenna Requirements

#### 5.1.1 Standard Applicable

FCC §15.203 & 15.247(b); RSS-247, 5.4 (6)


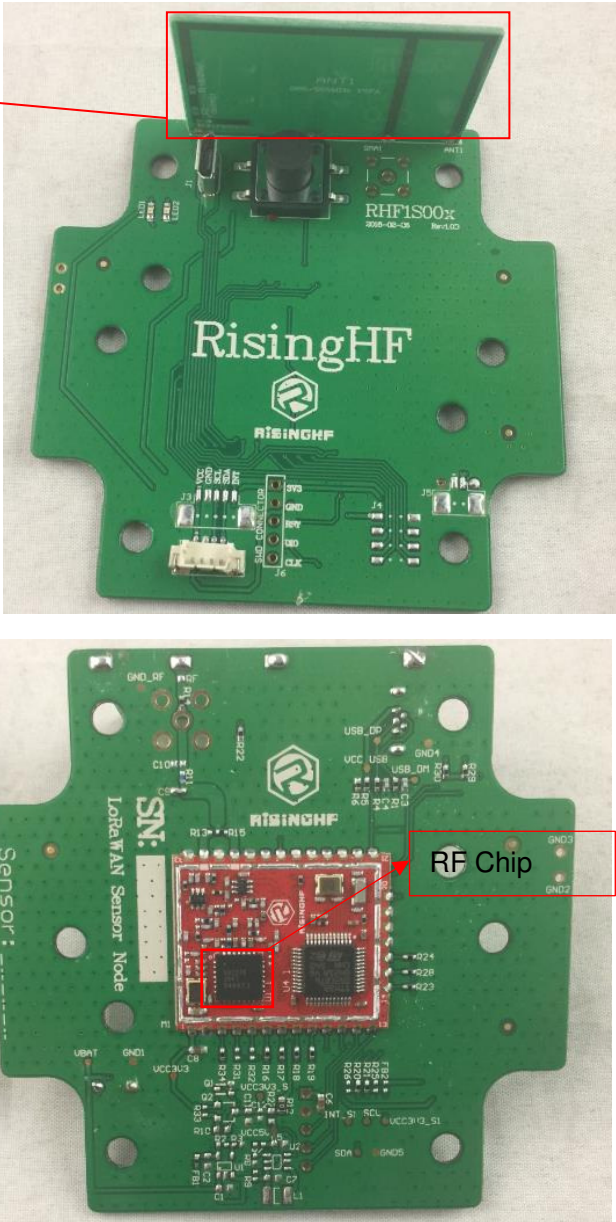
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of § 15.211, § 15.213, § 15.217, § 15.219, or § 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with § 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

If directional gain of transmitting antennas is greater than 6 dBi, the power shall be reduced by the same level in dB comparing to gain minus 6 dBi. For the fixed point-to-point operation, the power shall be reduced by one dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the FCC rule.

#### 5.1.2 Antenna Anti-Replacement Construction

The Antenna Anti-Replacement as following method:

Protected Method	Description
The antenna is An embedded-in	The antenna is welded on the mainboard, can't be replaced by the consumer

Reference Documents	Item
<p>Photo</p> <div data-bbox="145 309 416 387" style="border: 1px solid red; padding: 5px; display: inline-block;">PIFA Antenna</div> 	

### 5.1.3 Antenna Gain

The antenna peak gain of EUT is less than 6 dBi. Therefore, it is not necessary to reduce maximum peak output power limit.

## 5.2 Number of Hopping Frequencies

### 5.2.1 Limit

FCC §15.247(a) (1) (i); RSS-247, 5.1 (4)

For frequency hopping systems operating in the 902-928 MHz band: the system shall use at least 50 hopping frequencies.

#### Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

### 5.2.2 Test Procedure

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

Span = the frequency band of operation

RBW  $\geq$  1% of the span

VBW  $\geq$  RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize

### 5.2.3 Test Result

Please refer to ANNEX A.1.

## 5.3 Peak Output Power and E.I.R.P

### 5.3.1 Test Limit

FCC § 15.247(b)(1)

For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

RSS-247, 5.4 (2)

For FHSs operating in the band 902-928 MHz, the maximum peak conducted output power shall not exceed 1.0 W and the e.i.r.p. shall not exceed 4 W if the hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W and the e.i.r.p. shall not exceed 0.5 W if the hopset uses less than 75 hopping channels (see Section 5.4(5) for exceptions).

### 5.3.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

### 5.3.3 Test Procedure

The Module operates at hopping-off test mode. The lowest, middle and highest channels are selected to perform testing to verify the conducted RF output peak power of the Module.

Use the following spectrum analyzer settings:

Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel

RBW > the 20 dB bandwidth of the emission being measured

VBW  $\geq$  RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize.

### 5.3.4 Test Result

Please refer to ANNEX A.2.

## 5.4 Occupied Bandwidth

### 5.4.1 Limit

FCC §15.247(a)(1)(i); RSS-247, 5.1 (1)

Measurement of the 20dB bandwidth of the modulated signal. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

### 5.4.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

### 5.4.3 Test Procedure

Use the following spectrum analyzer settings:

Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel

RBW = in the range of 1% to 5% of the OBW

VBW  $\geq$  RBW

Sweep = auto

Detector function = peak

Trace = max hold

The EUT should be transmitting at its maximum data rate, Allow the trace to stabilize.

### 5.4.4 Test Result

Please refer to ANNEX A.3.

## 5.5 Carrier Frequency Separation

### 5.5.1 Limit

FCC §15.247(a)(1); RSS-247, 5.1 (2)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

### 5.5.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

### 5.5.3 Test Procedure

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

Span = wide enough to capture the peaks of two adjacent channels

Resolution (or IF) Bandwidth (RBW)  $\geq$  1% of the span

Video (or Average) Bandwidth (VBW)  $\geq$  RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

### 5.5.4 Test Result

Please refer to ANNEX A.4.

## 5.6 Time of Occupancy (Dwell time)

### 5.6.1 Limit

FCC §15.247(a)(1)(i); RSS-247, 5.1 (4)

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period.

### 5.6.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

### 5.6.3 Test Procedure

The lowest, middle and highest channels are selected to perform testing to record the dwell time of each occupation measured in this channel, which is called Pulse Time here.

### 5.6.4 Test Result

Please refer to ANNEX A.5

## 5.7 Conducted Spurious Emission & Authorized-band band-edge

### 5.7.1 Limit

FCC §15.247(d); RSS-247, 5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

### 5.7.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

### 5.7.3 Test Procedure

Use the following spectrum analyzer settings:

Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.

RBW = 100 kHz

VBW  $\geq$  RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize

### 5.7.4 Test Result

Please refer to ANNEX A.6 and A.7



## 5.8 Conducted Emission

### 5.8.1 Limit

FCC §15.207; RSS-GEN, 8.8

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 $\mu$ H/50 $\Omega$  line impedance stabilization network (LISN).

Frequency range (MHz)	Conducted Limit (dB $\mu$ V)	
	Quai-peak	Average
0.15 - 0.50	66 to 56	56 to 46
0.50 - 5	56	46
0.50 - 30	60	50

### 5.8.2 Test Setup

See section 4.4.2 for test setup description for the AC power supply port. The photo of test setup please refer to ANNEX B.

### 5.8.3 Test Procedure

The maximum conducted interference is searched using Peak (PK), if the emission levels more than the AV and QP limits, and that have narrow margins from the AV and QP limits will be re-measured with AV and QP detectors. Tests for both L phase and N phase lines of the power mains connected to the EUT are performed. Refer to recorded points and plots below.

Devices subject to Part 15 must be tested for all available U.S. voltages and frequencies (such as a nominal 120 VAC, 50/60 Hz and 240 VAC, 50/60 Hz) for which the device is capable of operation. A device rated for 50/60 Hz operation need not be tested at both frequencies provided the radiated and line conducted emissions are the same at both frequencies.

### 5.8.4 Test Result

Please refer to ANNEX A.7.

## 5.9 Radiated Spurious Emission

### 5.9.1 Limit

FCC §15.209&15.247(d); RSS-247, 5.5

Radiated emission outside the frequency band attenuation below the general limits specified in FCC section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in FCC section 15.205(a), must also comply with the radiated emission limits specified in FCC section 15.209(a).

According to FCC section 15.209 (a), except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength ( $\mu\text{V}/\text{m}$ )	Measurement Distance (m)
0.009 - 0.490	902/F(kHz)	300
0.490 - 1.705	9020/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

Note:

1. Field Strength (dB $\mu\text{V}/\text{m}$ ) =  $20 \cdot \log[\text{Field Strength } (\mu\text{V}/\text{m})]$ .
2. In the emission tables above, the tighter limit applies at the band edges.
3. For Above 1000 MHz, the emission limit in this paragraph is based on measurement instrumentation employing an average detector, measurement using instrumentation with a peak detector function, corresponding to 20dB above the maximum permitted average limit.
4. For above 1000 MHz, limit field strength of harmonics: 54dB $\mu\text{V}/\text{m}@3\text{m}$  (AV) and 74dB $\mu\text{V}/\text{m}@3\text{m}$  (PK).

### 5.9.2 Test Setup

See section 4.4.3 to 4.4.5 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

### 5.9.3 Test Procedure

The measurement frequency range is from 9 kHz to the 10th harmonic of the fundamental frequency. The Turn Table is actuated to turn from  $0^\circ$  to  $360^\circ$ , and both horizontal and vertical polarizations of the Test Antenna are used to find the maximum radiated power. Mid channels on all channel bandwidth verified. Only the worst RB size/offset presented.

The power of the EUT transmitting frequency should be ignored.

All Spurious Emission tests were performed in X, Y, Z axis direction. And only the worst axis test condition was recorded in this test report.

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured

RBW = 1 MHz for  $f \geq 1$  GHz, 100 kHz for  $f < 1$  GHz

VBW  $\geq$  RBW

Sweep = auto

Detector function = peak

Trace = max hold

For measurement below 1GHz, If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported, Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

#### 5.9.4 Test Result

Please refer to ANNEX A.8.

## 5.10 Band Edge (Restricted-band band-edge)

### 5.10.1 Limit

FCC §15.209&15.247(d)

Radiated emission outside the frequency band attenuation below the general limits specified in FCC section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in FCC section 15.205(a), must also comply with the radiated emission limits specified in FCC section 15.209(a).

### 5.10.2 Test Setup

See section 4.4.3 to 4.4.5 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

### 5.10.3 Test Procedure

The measurement frequency range is from 9 kHz to the 10th harmonic of the fundamental frequency. The Turn Table is actuated to turn from 0° to 360°, and both horizontal and vertical polarizations of the Test Antenna are used to find the maximum radiated power. Mid channels on all channel bandwidth verified. Only the worst RB size/offset presented.

The power of the EUT transmitting frequency should be ignored.

All Spurious Emission tests were performed in X, Y, Z axis direction. And only the worst axis test condition was recorded in this test report.

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured

RBW = 1 MHz for  $f \geq 1$  GHz, 100 kHz for  $f < 1$  GHz

VBW  $\geq$  RBW

Sweep = auto

Detector function = peak

Trace = max hold

For measurement below 1GHz, If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported, Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

### 5.10.4 Test Result

Please refer to ANNEX A.9.

## 5.11 Power Spectral density (PSD)

### 5.11.1 Limit

FCC §15.247(e); RSS-247, 5.2 (2)

The same method of determining the conducted output power shall be used to determine the power spectral density. If a peak output power is measured, then a peak power spectral density measurement is required. If an average output power is measured, then an average power spectral density measurement should be used.

The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of Section 5.4(4), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

### 5.11.2 Test Setup

See section 4.4.1 (Diagram 1) for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

### 5.11.3 Test Procedure

Set analyzer center frequency to DTS channel center frequency.

Set the span to 1.5 times the DTS bandwidth.

Set the RBW to:  $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$ .

Set the VBW  $\geq 3$  RBW.

Detector = peak.

Sweep time = auto couple.

Trace mode = max hold.

Allow trace to fully stabilize.

Use the peak marker function to determine the maximum amplitude level within the RBW.

If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

### 5.11.4 Test Result

Please refer to ANNEX A.10.

# ANNEX A TEST RESULT

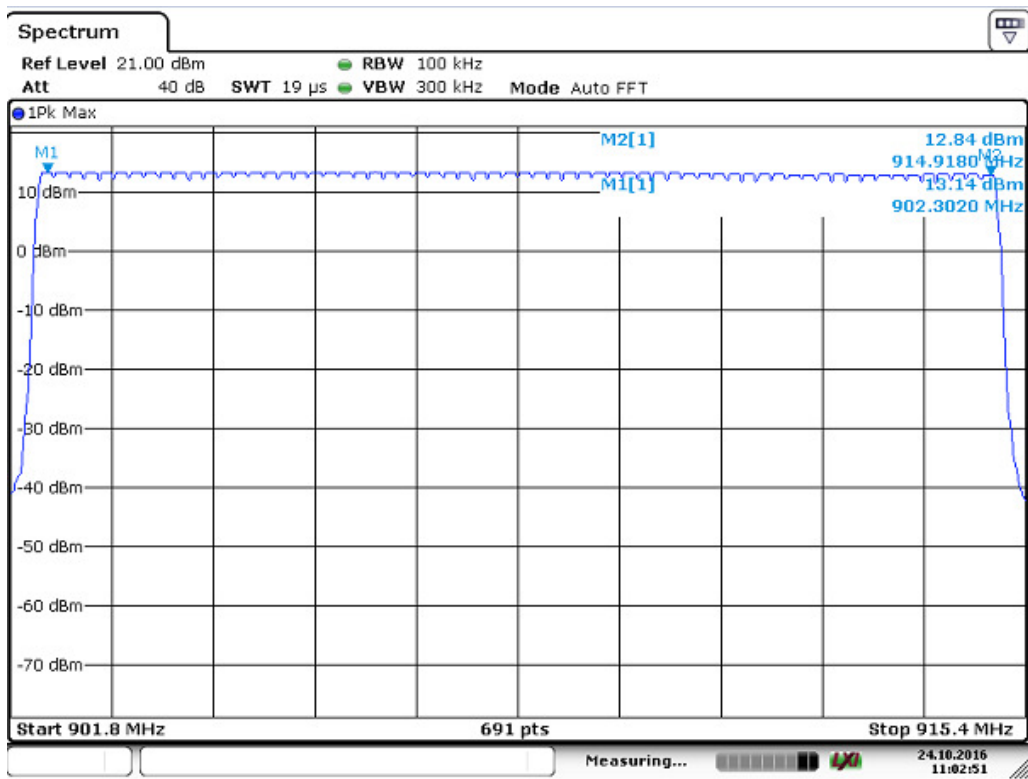
## A.1 Number of Hopping Frequency

### Test Data

Test Mode	Frequency Block (MHz)	Measured Channel Numbers	Min. Limit	Verdict
LoRa	902-928	64	50	Pass

### Test plots

LoRa



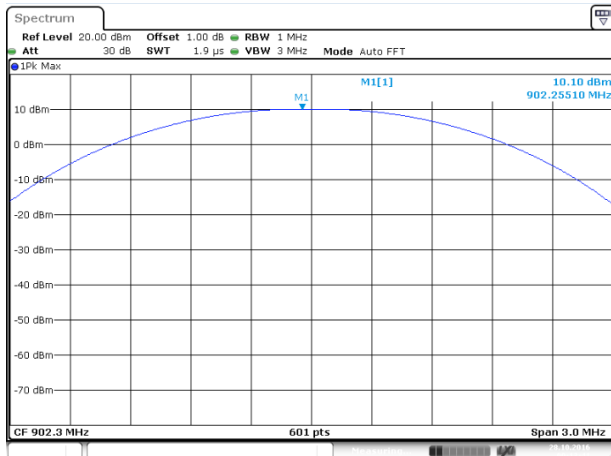
## A.2 Peak Output Power

### Peak Power Test Data

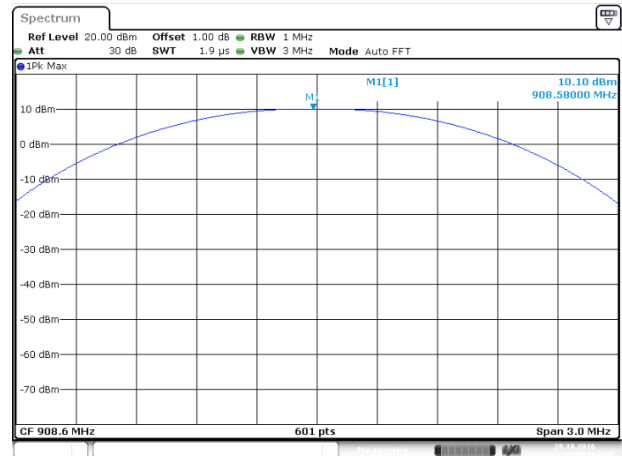
Channel	Measured Output Peak Power		Limit		Verdict
	LoRa		dBm	mW	
	dBm	mW			
Low	10.10	10.23	30	1000	Pass
Middle	10.10	10.23			Pass
High	10.02	10.05			Pass

### Test plots

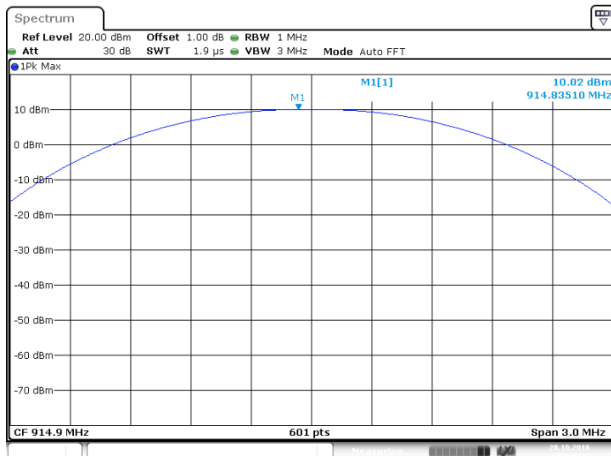
#### LOW CHANNEL



#### MIDDLE CHANNEL



#### HIGH CHANNEL



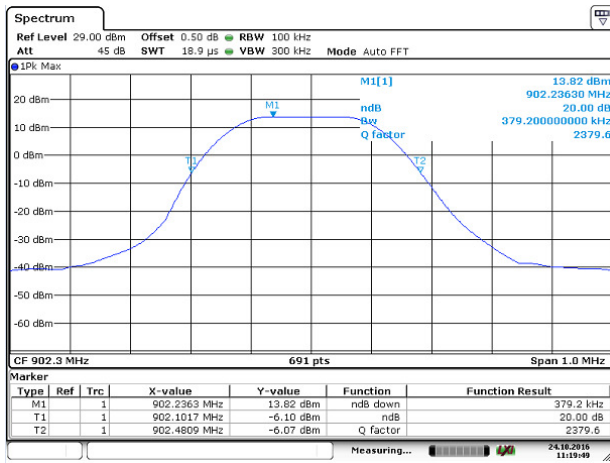
### A.3 20 dB and 99% bandwidth

#### Test Data

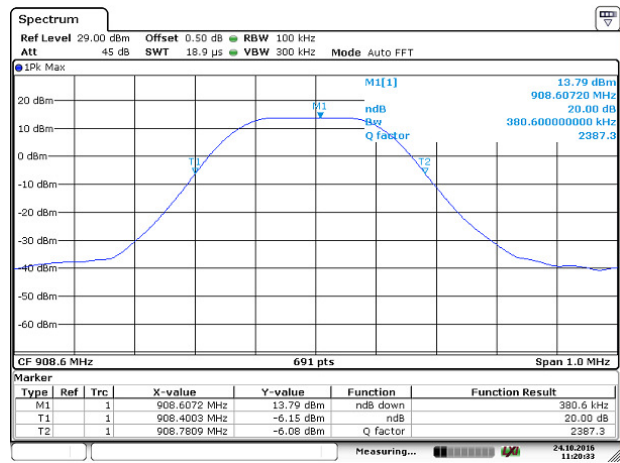
LoRa				
Channel	20 dB Bandwidth (kHz)	99% Bandwidth (kHz)	Limit of 20 dB Bandwidth (kHz)	Verdict
Low	379.2	316.93	500	Pass
Middle	380.6	316.93	500	Pass
High	380.6	316.93	500	Pass

#### Test plots (20 dB Bandwidth)

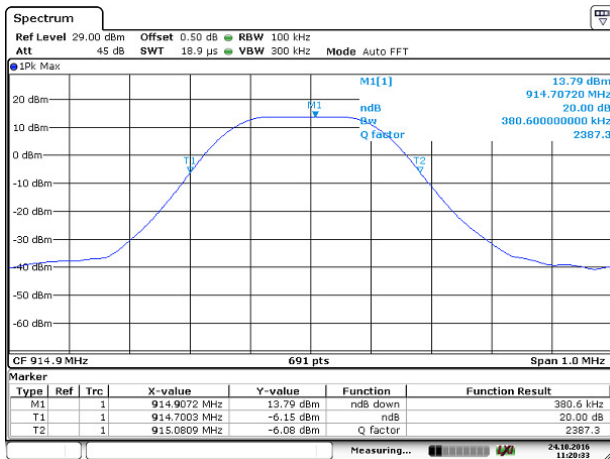
##### LOW CHANNEL



##### MIDDLE CHANNEL



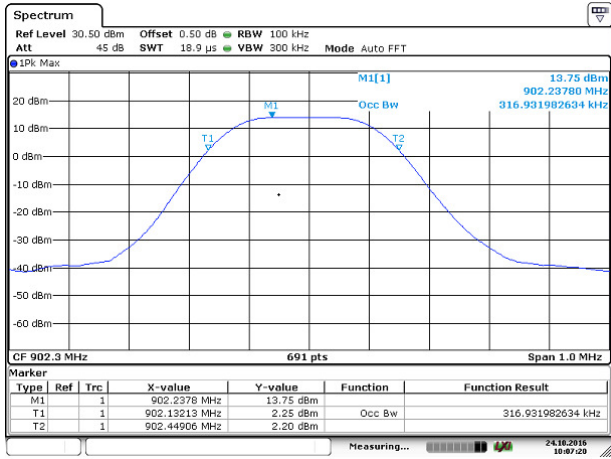
##### HIGH CHANNEL



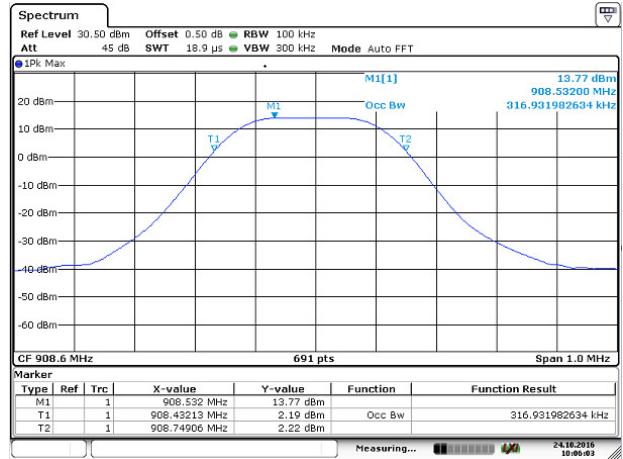


Test plots (99% Bandwidth)

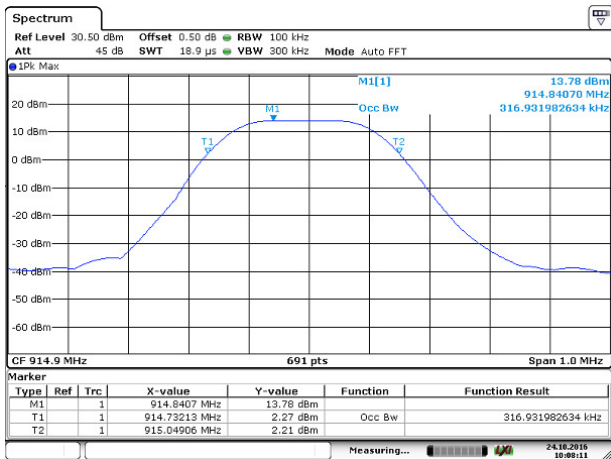
LOW CHANNEL



MIDDLE CHANNEL



HIGH CHANNEL



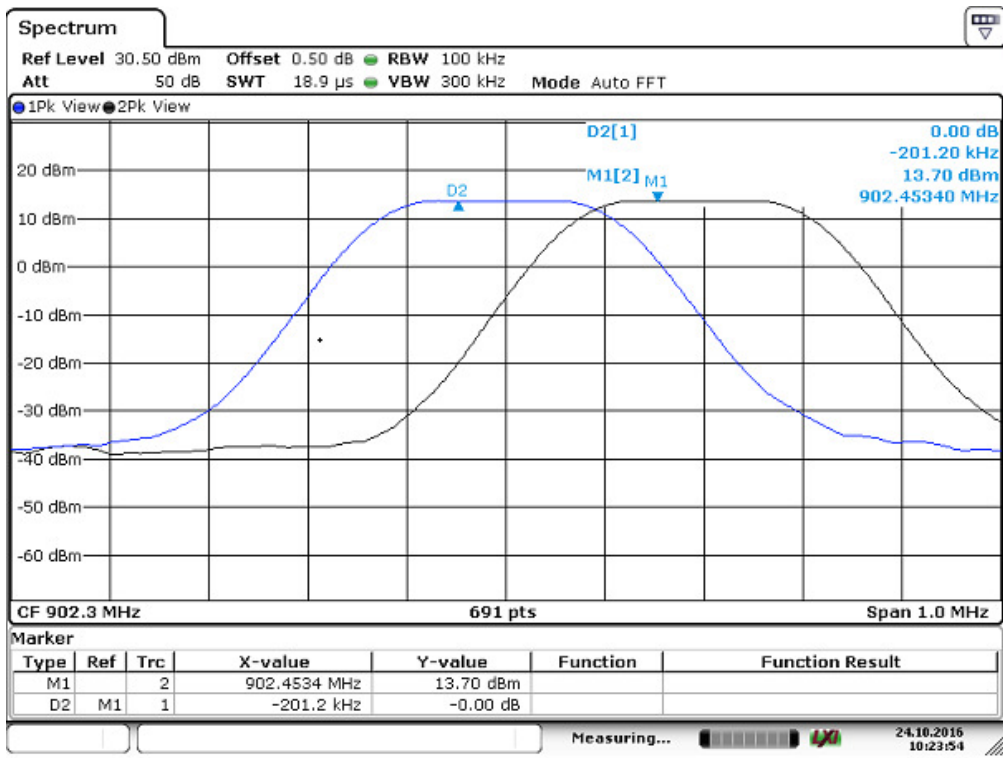
### A.4 Hopping Frequency Separation

Test Data

Mode	Frequency separation (MHz)	Max 20 dB Bandwidth (MHz)	Verdict
LoRa	201.200	380.600	Pass

Test Plots

LoRa

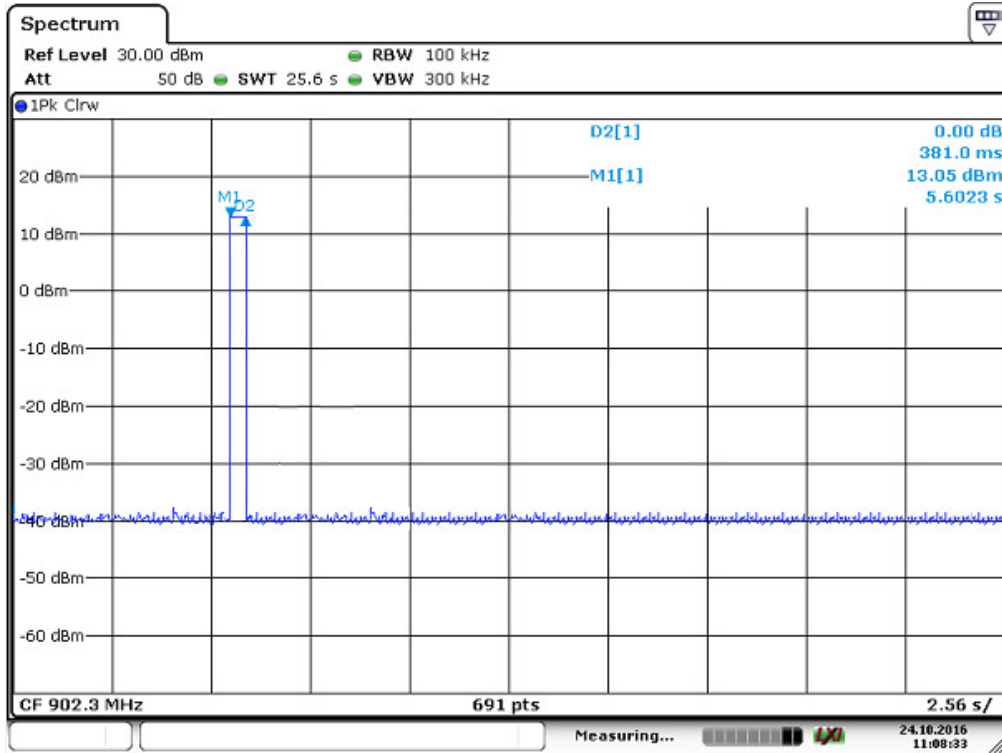


### A.5 Average Time of Occupancy

Test Data

Total of Dwell(ms)	Limit (sec)	Verdict
381.0	0.4	Pass

LoRa



## A.6 Conducted Spurious Emissions

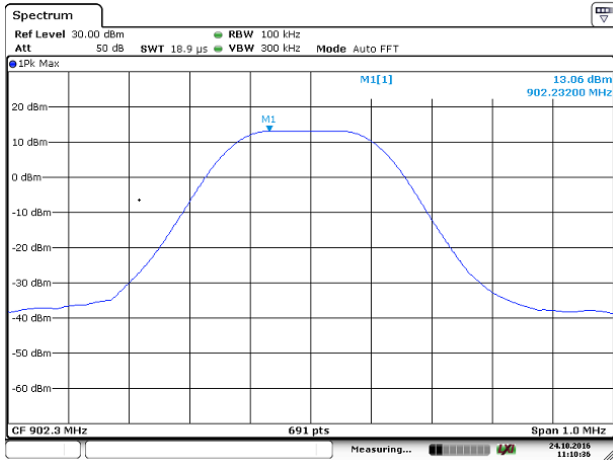
### Test Data

LoRa				
Channel	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
Low	-38.50	13.06	-6.94	Pass
Middle	-38.55	13.63	-6.37	Pass
High	-37.42	13.71	-6.29	Pass

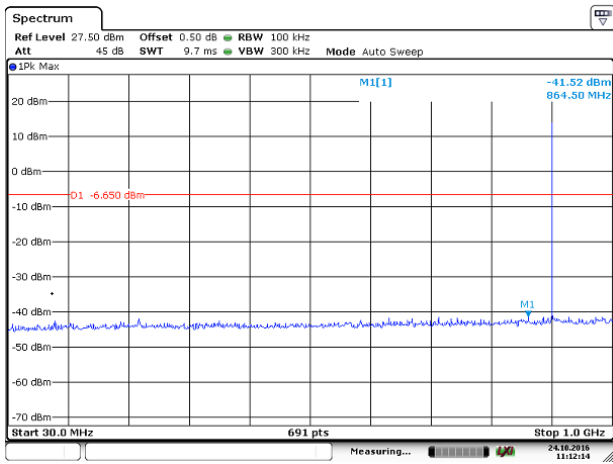
Hopping Mode				
Mode	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
LoRa	-38.00	12.84	-7.16	Pass

Test Plots

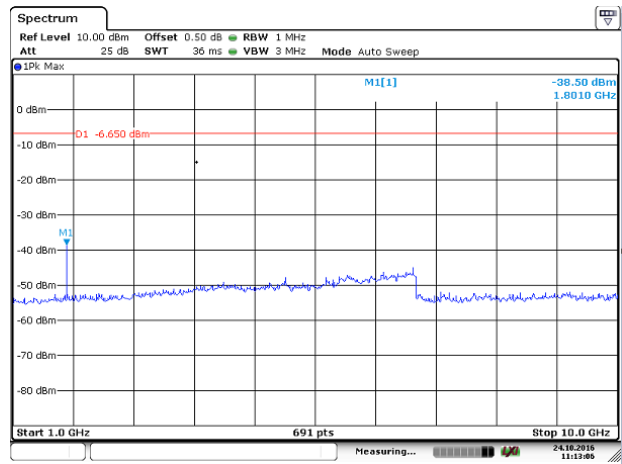
LOW CHANNEL, CARRIER LEVEL



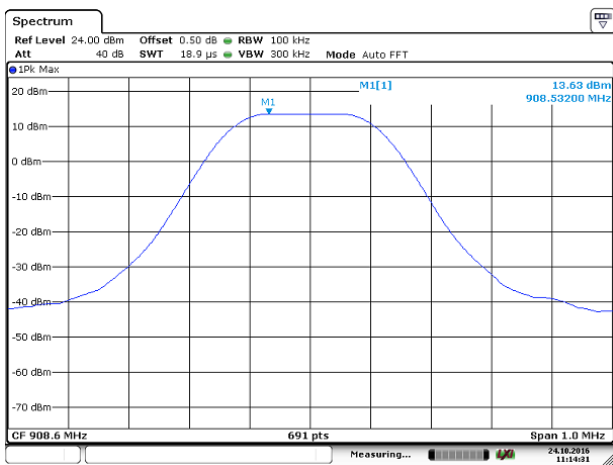
LOW CHANNEL, SPURIOUS 30 MHz ~ 1 GHz



LOW CHANNEL, SPURIOUS 1 GHz ~ 10 GHz

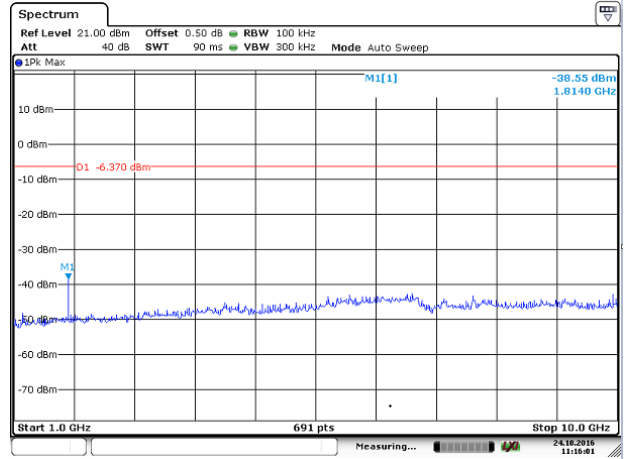
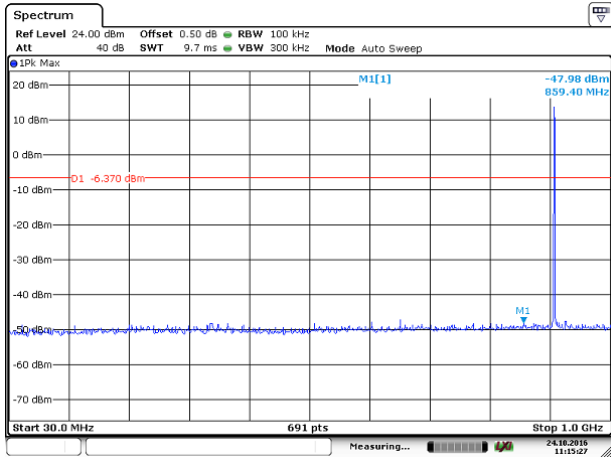


MIDDLE CHANNEL, CARRIER LEVEL



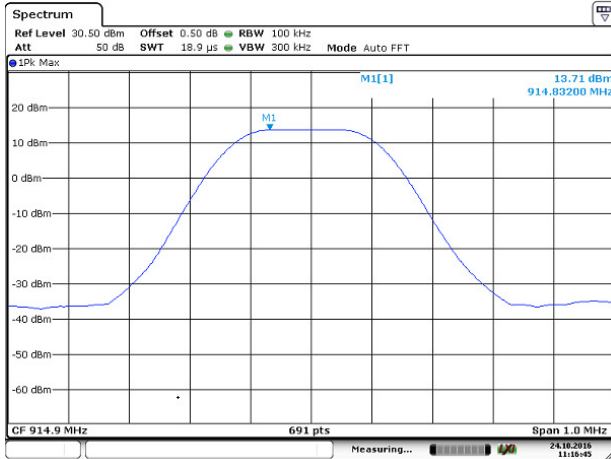
MIDDLE CHANNEL , SPURIOUS 30 MHz ~ 1 GHz

MIDDLE CHANNEL , SPURIOUS 1 GHz ~ 10 GHz



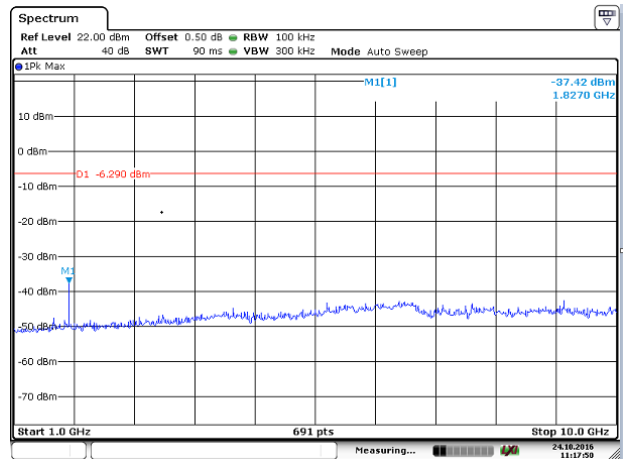
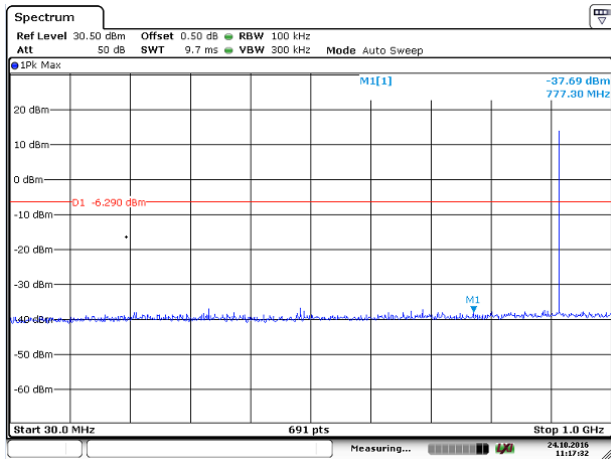
HIGH CHANNEL, CARRIER LEVEL

HIGH CHANNEL , BAND EDGE

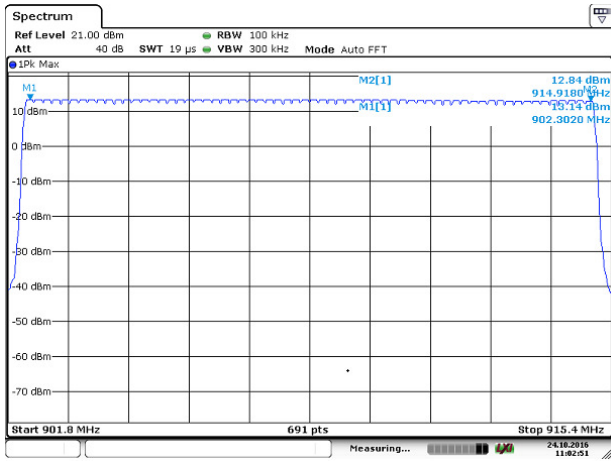


HIGH CHANNEL , SPURIOUS 30 MHz ~ 1 GHz

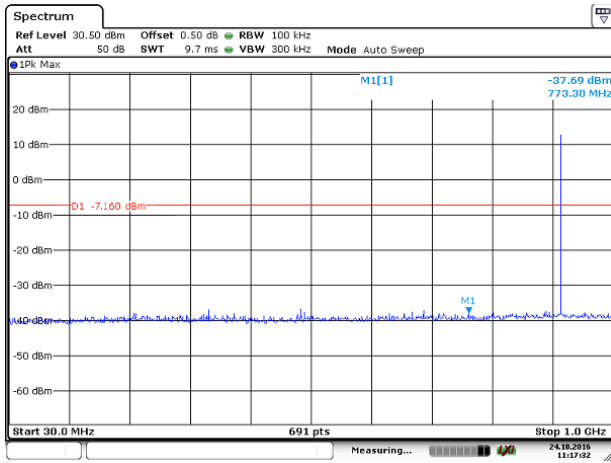
HIGH CHANNEL , SPURIOUS 1 GHz ~ 10 GHz



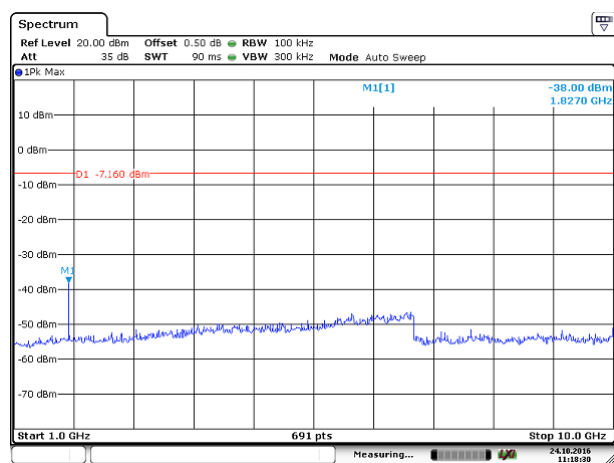
HOPPING, CARRIER LEVEL



Hopping Mode, SPURIOUS 30 MHz ~ 1 GHz



Hopping Mode, SPURIOUS 1GHz ~ 10 GHz



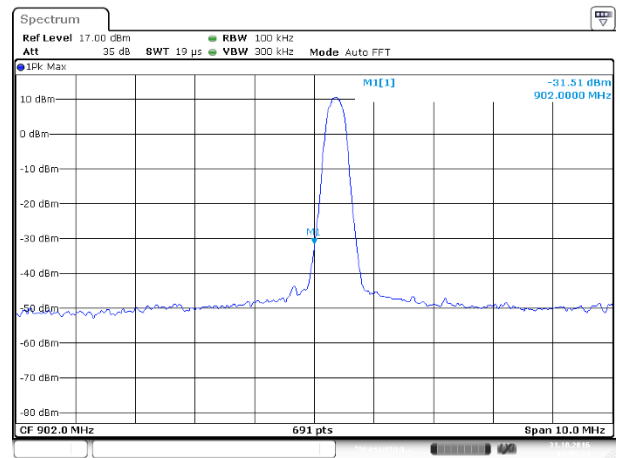
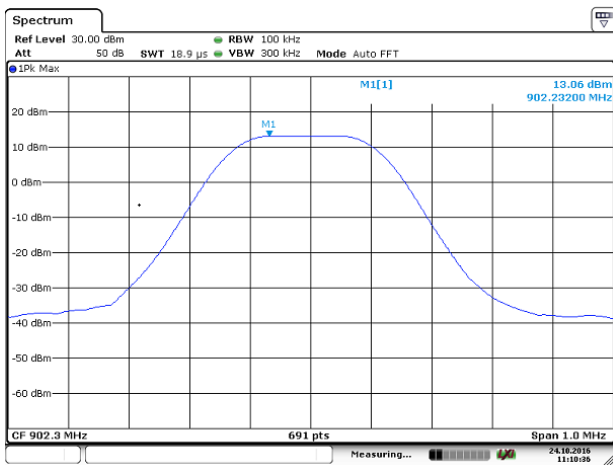
### A.7 Band-edge-Authorized-band

Channel	Measured Max. Band Edge Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
Low Channel	-34.56	13.06	-6.94	Pass
High Channel	-42.99	13.71	-6.29	Pass

#### Test Plots

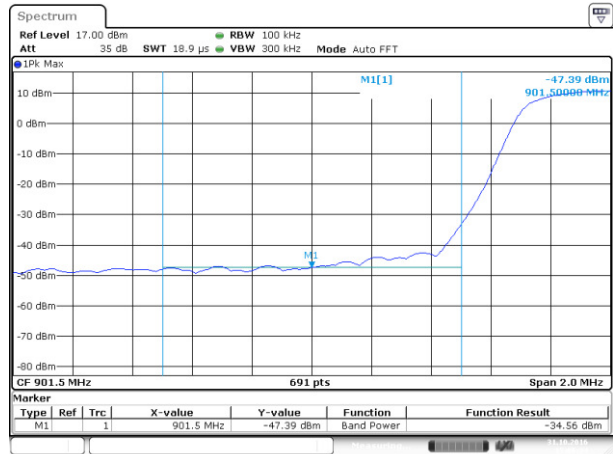
LOW CHANNEL, Carrier level

LOW CHANNEL, Reference level



Date: 31.OCT.2016 15:05:55

LOW CHANNEL, Band Edge

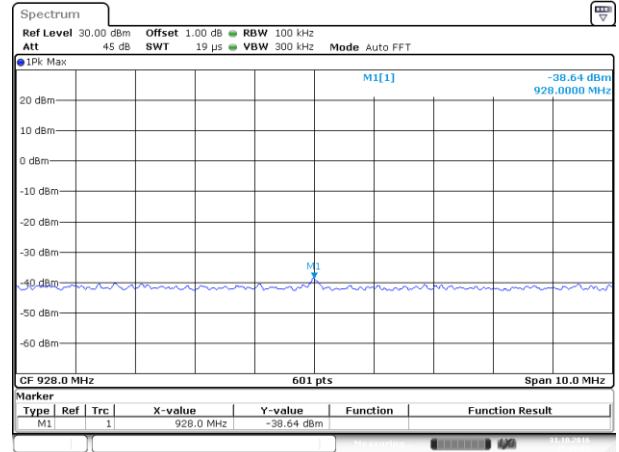
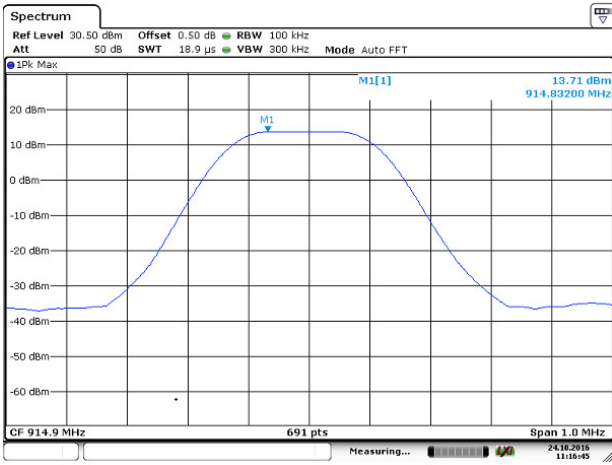


Date: 31.OCT.2016 15:06:34



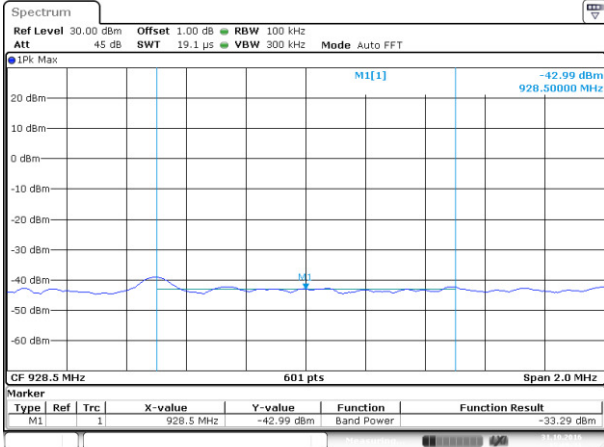
High CHANNEL, Carrier level

High CHANNEL, Reference level



Date: 31.OCT.2016 15:09:01

LOW CHANNEL, Band Edge



Date: 31.OCT.2016 15:09:31

## A.8 Conducted Emissions

N/A

## A.9 Radiated Spurious Emission

Note 1: The symbol of "--" in the table which means not application.

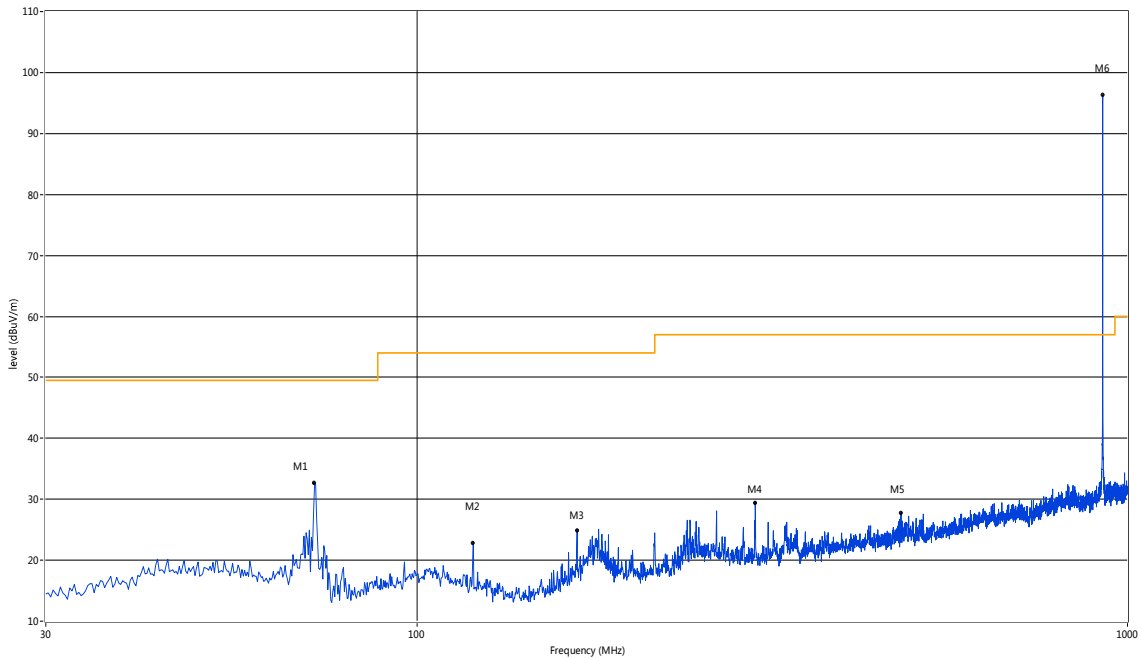
Note 2: For the test data above 1 GHz, according to the ANSI C63.10-2013, where limits are specified for both average and peak (or quasi-peak) detector functions, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement.

Note 3: The low frequency, which started from 9 kHz to 30 MHz, was pre-scanned and the result which was 20 dB lower than the limit line per 15.31(o) was not reported.

Note 4: The worst configurations is below 1 GHz, only the worst configuration (Low Channel) shown here.

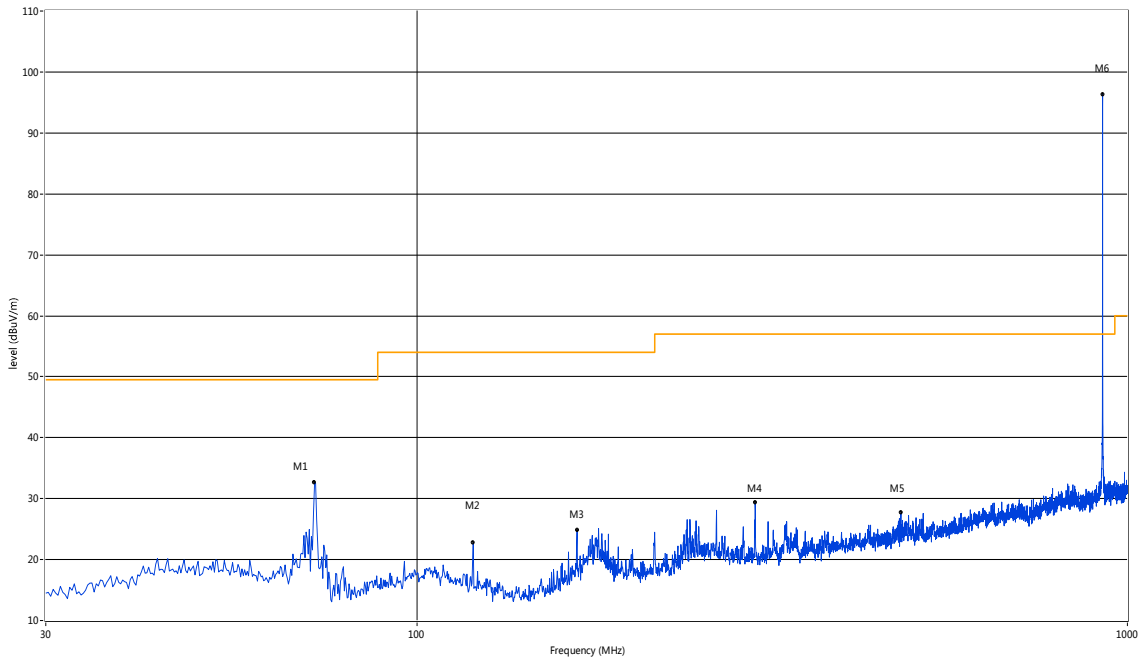
### Test Data and Plots

LOW CHANNEL ANT V



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (o)	Height (cm)	ANT	Verdict
1	71.700	32.63	-23.36	49.5	16.87	Peak	344.00	100	Vertical	Pass
2	119.945	22.74	-21.74	54.0	31.26	Peak	7.00	100	Vertical	Pass
3	167.948	24.85	-22.82	54.0	29.15	Peak	360.00	100	Vertical	Pass
4	299.108	29.28	-17.67	57.0	27.72	Peak	121.90	100	Vertical	Pass
5	479.968	27.65	-13.81	57.0	29.35	Peak	152.10	100	Vertical	Pass
6	902.300	96.29	-5.24	57.0	-39.29	Peak	94.00	100	Vertical	Pass

LOW CHANNEL, ANT H



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (o)	Height (cm)	ANT	Verdict
1	71.700	32.63	-23.36	49.5	16.87	Peak	344.00	100	Horizontal	Pass
2	119.945	22.74	-21.74	54.0	31.26	Peak	7.00	100	Horizontal	Pass
3	167.948	24.85	-22.82	54.0	29.15	Peak	360.00	100	Horizontal	Pass
4	299.108	29.28	-17.67	57.0	27.72	Peak	121.90	100	Horizontal	Pass
5	479.968	27.65	-13.81	57.0	29.35	Peak	152.10	100	Horizontal	Pass
6	902.300	96.29	-5.24	57.0	-39.29	Peak	94.00	100	Horizontal	N/A

## LOW CHANNEL 1 GHz to 10 GHz, ANT V

No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (o)	Height (cm)	ANT	Verdict
1	1025.99	39.63	-6.13	74	34.37	Peak	209.6	150	Vertical	Pass
2	1500.38	41.55	-4.59	74	32.45	Peak	271.7	150	Vertical	Pass
3	1929.77	42.68	-3.61	74	31.32	Peak	141.6	150	Vertical	Pass
4	6920.97	44.32	17.59	74	29.68	Peak	188.1	150	Vertical	Pass
5	7314.06	46.01	8.73	74	27.99	Peak	342.5	150	Vertical	Pass
6	7830.70	46.83	11.07	74	27.17	Peak	348	150	Vertical	Pass

## LOW CHANNEL 1 GHz to 10 GHz, ANT H

No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (o)	Height (cm)	ANT	Verdict
1	1178.96	41.36	-5.99	74	32.64	Peak	201.2	150	Horizontal	Pass
2	1461.39	44.75	0.82	74	29.26	Peak	304.1	150	Horizontal	Pass
3	1698.33	51.34	14.58	74	22.66	Peak	303.1	150	Horizontal	Pass
4	6438.02	44.20	19.07	74	29.80	Peak	72.9	150	Horizontal	Pass
5	7482.53	43.28	11.38	74	30.72	Peak	114.4	150	Horizontal	Pass
6	8336.11	47.63	11.63	74	26.37	Peak	122	150	Horizontal	Pass

## MIDDLE CHANNEL 1 GHz to 10 GHz, ANT V

No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (o)	Height (cm)	ANT	Verdict
1	1316.42	40.55	-6.15	74	33.45	Peak	214	150	Vertical	Pass
2	1526.87	42.63	-4.20	74	31.37	Peak	264.6	150	Vertical	Pass
3	1878.28	40.44	-3.62	74	33.56	Peak	301	150	Vertical	Pass
4	6584.03	46.01	16.11	74	27.99	Peak	3.5	150	Vertical	Pass
5	7381.45	46.64	9.35	74	27.36	Peak	113	150	Vertical	Pass
6	8257.49	50.66	12.27	74	23.34	Peak	171	150	Vertical	Pass

## MIDDLE CHANNEL 1 GHz to 10 GHz, ANT H

No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (o)	Height (cm)	ANT	Verdict
1	1038.49	46.85	-4.43	74	27.15	Peak	355.7	150	Horizontal	Pass
2	1403.40	47.26	9.14	74	26.74	Peak	309.6	150	Horizontal	Pass
3	1923.27	46.87	12.98	74	27.13	Peak	170.8	150	Horizontal	Pass
4	6797.42	47.99	17.46	74	26.01	Peak	312.6	150	Horizontal	Pass
5	7314.06	46.96	9.52	74	27.04	Peak	72.3	150	Horizontal	Pass
6	7875.62	47.36	11.09	74	26.64	Peak	178.9	150	Horizontal	Pass

## HIGH CHANNEL 1 GHz to 10 GHz, ANT V

No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (o)	Height (cm)	ANT	Verdict
1	1206.45	41.21	-5.18	74	32.79	Peak	170.3	150	Vertical	Pass
2	1392.90	42.11	-4.67	74	31.89	Peak	217.3	150	Vertical	Pass
3	1924.77	41.10	-3.11	74	32.90	Peak	248.4	150	Vertical	Pass
4	6089.85	44.39	14.42	74	29.61	Peak	177.9	150	Vertical	Pass
5	7336.52	44.04	9.01	74	29.96	Peak	255.4	150	Vertical	Pass
6	8201.33	43.79	11.86	74	30.21	Peak	355.5	150	Vertical	Pass

## HIGH CHANNEL 1 GHz to 10 GHz, ANT H

No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (o)	Height (cm)	ANT	Verdict
1	1161.46	39.04	-1.69	74	34.96	Peak	316.9	150	Horizontal	Pass
2	1470.38	44.62	9.02	74	29.38	Peak	317.3	150	Horizontal	Pass
3	1847.79	44.60	10.74	74	29.40	Peak	87.1	150	Horizontal	Pass
4	6157.24	47.48	14.24	74	26.52	Peak	192.1	150	Horizontal	Pass
5	7448.84	45.18	9.00	74	28.82	Peak	158.8	150	Horizontal	Pass
6	7740.85	47.32	11.04	74	26.69	Peak	301.9	150	Horizontal	Pass

## Hopping Low Channel 1 GHz to 10 GHz, ANT V

No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (o)	Height (cm)	ANT	Verdict
1	1053.99	39.59	-6.00	74	34.41	Peak	132.4	150	Vertical	Pass
2	1546.36	43.26	-4.37	74	30.74	Peak	104.5	150	Vertical	Pass
3	1596.35	44.56	-4.06	74	29.44	Peak	45.7	150	Vertical	Pass
4	7797.01	41.65	20.40	74	32.35	Peak	284.1	150	Vertical	Pass
5	8632.30	41.79	8.57	74	32.21	Peak	86.8	150	Vertical	Pass
6	9449.25	44.35	9.43	74	29.66	Peak	140.6	150	Vertical	Pass

## Hopping Low Channel 1 GHz to 10 GHz, ANT H

No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (o)	Height (cm)	ANT	Verdict
1	1244.44	43.79	-0.59	74	30.21	Peak	4.7	150	Horizontal	Pass
2	1418.40	45.34	2.47	74	28.66	Peak	251.2	150	Horizontal	Pass
3	5632.25	48.14	10.48	74	25.86	Peak	5.3	150	Horizontal	Pass
4	7583.61	44.78	13.57	74	29.22	Peak	11.5	150	Horizontal	Pass
5	6112.31	43.78	9.18	74	30.22	Peak	263.2	150	Horizontal	Pass
6	8730.03	48.22	11.22	74	25.78	Peak	106.8	150	Horizontal	Pass

## A.10 Band Edge (Restricted-band band-edge)

PASS

Note: The adjacent to the restricted frequency band (608-614MHz and 960-1240MHz) is far away the fundamental, it is noise only. Please refer to Section A.8 for test data.

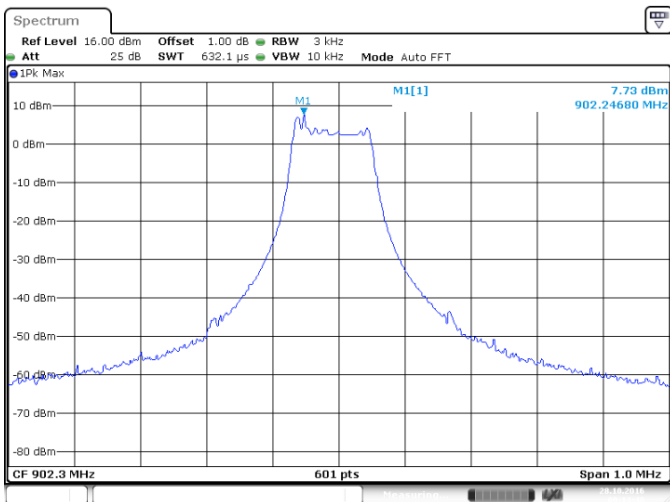
## A.11 Power Spectral Density (PSD)

### Test Data

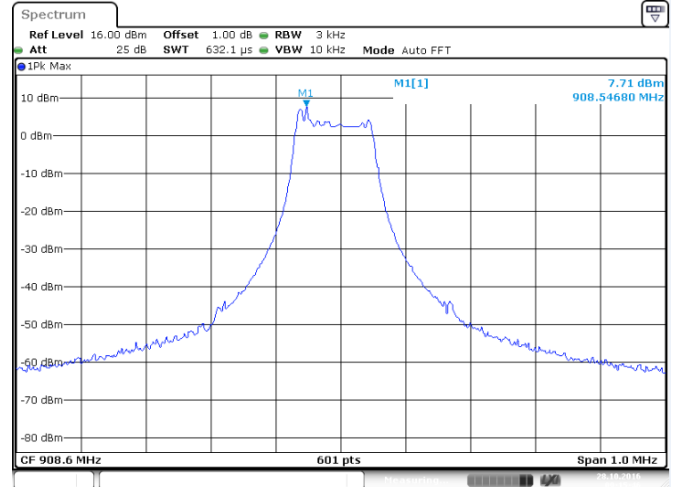
Channel	Spectral power density (dBm/3kHz)	Limit (dBm/3kHz)	Verdict
Low Channel	7.73	8	Pass
Middle Channel	7.71	8	Pass
High Channel	7.67	8	Pass

### Test plots

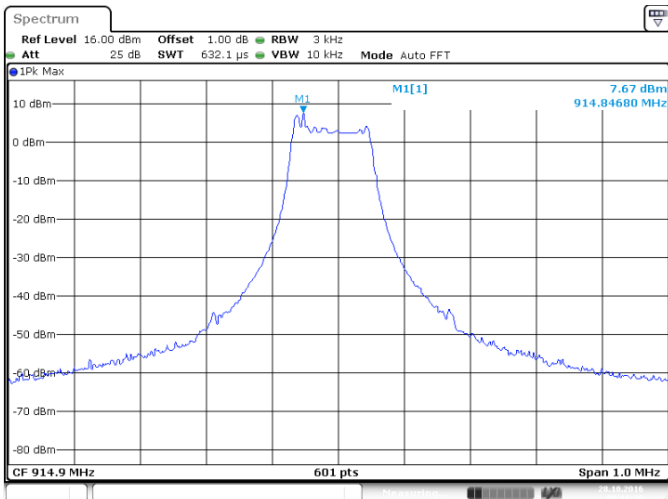
#### LOW CHANNEL



#### MIDDLE CHANNEL



#### HIGH CHANNEL



## **ANNEX B TEST SETUP PHOTOS**

Please refer the document “BL-SZ1690394-AR.PDF”.

## **ANNEX C EUT EXTERNAL PHOTOS**

Please refer the document “BL- SZ1690394-AW.PDF”.

## **ANNEX D EUT INTERNAL PHOTOS**

Please refer the document “BL- SZ1690394-AI.PDF”.

--END OF REPORT--